Goal-based Ecological Management and Objective-based Monitoring

Increasing the
Focus, Precision and Efficiency
of Monitoring for
Ecological Management and
Restoration

Goal-based Management Values for Conservation:

- provides a vision of future conditions
- guides conservation and management actions
- establishes spatial and temporal priorities
- provides the basis for evaluation

Goal-based Management Values for the Institution:

- sense of purpose
- focused creativity
- clear priorities
- efficient and effective use of time, talent, and tools
- measurable success

Presentation Outline

- Monitoring and a Monitoring Framework
- Desired Future Conditions
  - What is the ultimate goal of ecological management?
- Management Objectives
  - What is being measured?
  - How is it being measured?
- Sampling Objectives
  - How precise will the data be?
- Workshops and Collaboration
  - How do one learn objective-based monitoring?
  - Where can one get information for goals & objectives?

"You can observe a lot by watching" *Yogi Berra*

- Monitoring:

  the process of acquiring information

  - at the appropriate scale and timeframe
  - to assess status and detect change/trend of populations, communities and ecological systems over time
  - for the purpose of evaluating and directing management actions
- Monitoring is the "critical link" or "cornerstone" of adaptive management

Types of Monitoring (USFS)

- Implementation Monitoring
  - determine if a planned activity was accomplished
  - asks Did we do what we said we would do?
- Effectiveness Monitoring
  - determine if activity achieved stated objectives
  - asks Did it work? Is it working?
- Validation Monitoring
  - determine if assumptions and models are correct
  - questions form the basis of research needs

Levels of Monitoring

- Qualitative/Semi-Qualitative Monitoring

  presence/absence, area, estimates of numbers, photo-points, mapping

  + quick, inexpensive, whole population/community assessment

  - not repeatable, subjective, descriptive, detects only dramatic change

- Quantitative Monitoring

  number, density, cover, frequency, biomass

  + Data can be analyzed, repeatable

  - Resource Intensive, Specialized Expertise

- Quantitative Age or Stage Class Analysis

  individual fates: survival, mortality, fecundity

  + Predictive, More Insights

  - Resource Intensive, Time Intensive, Specialize Expertise

Monitoring versus Experiments

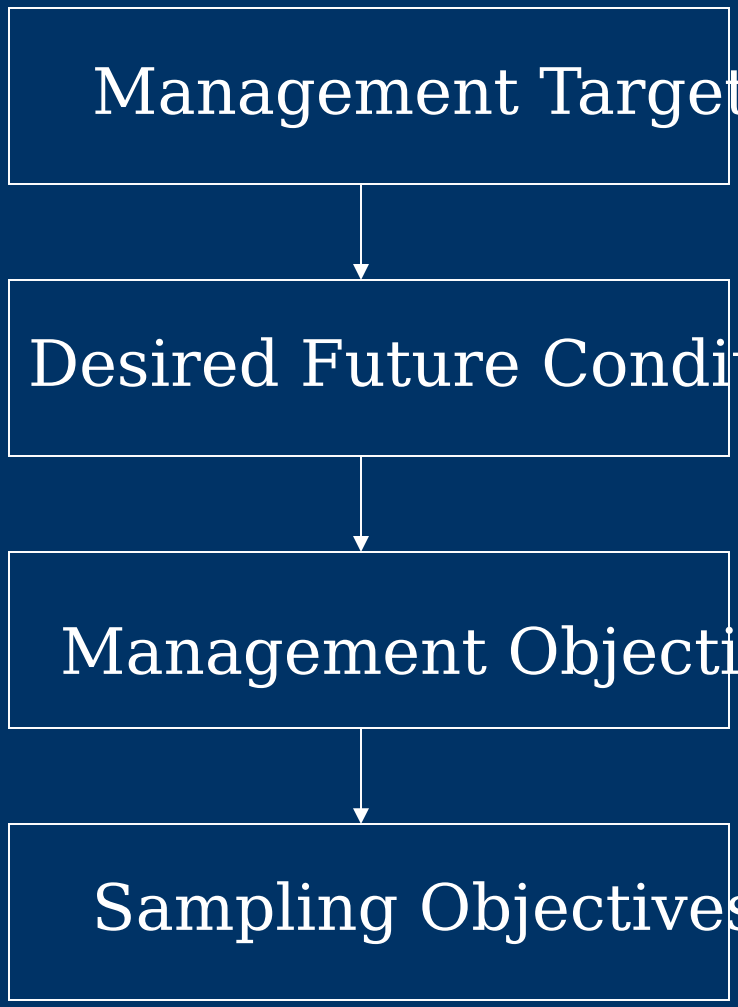
Monitoring

- Goal is to detect change
- Characteristics
  - pre or post monitoring
  - usually no control, but can have “untreated”
  - none or minimal replication
- Should always be related to a management objective

Experimental Research

- Goal is to statistically infer cause and effect
- Characteristics
  - always pre and post monitoring
  - always control and treatments
  - always replication
- Not always related to a management objective

Monitoring Framework: from Targets to Trends



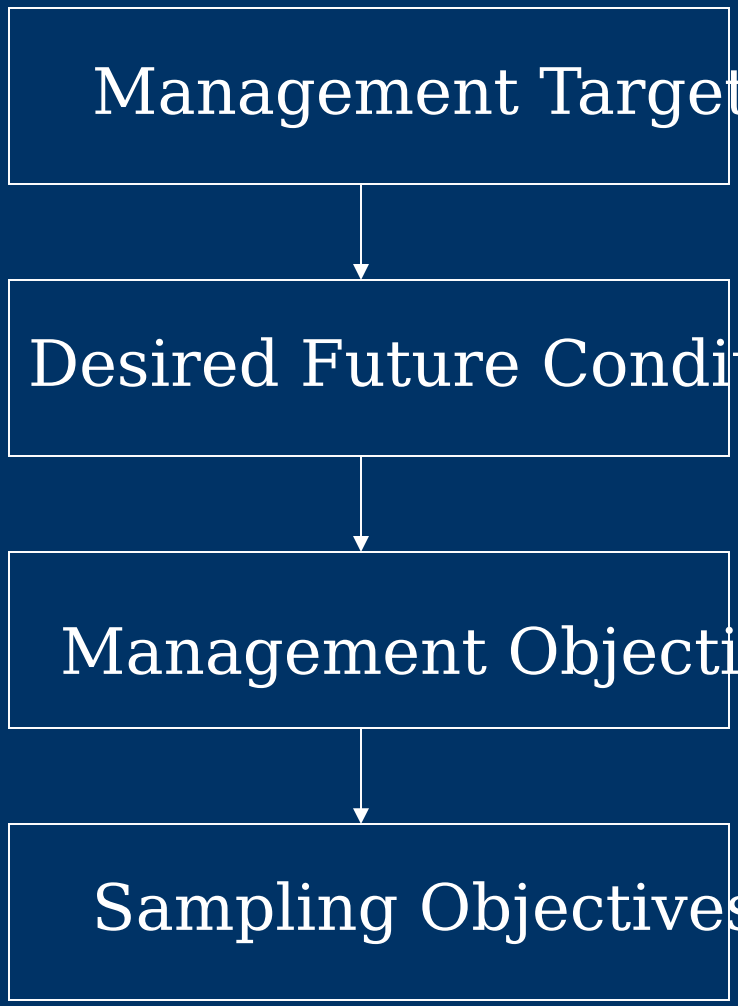
Priority species and ecologica
systems for management

Ultimate goal of managemen
Current status and needs

How to manage to meet DFC
Attributes monitored for suc

Data to detect change or tre

Monitoring Framework: from Targets to Trends



Integrated Natural Resourc
Management Plan

Management Plans and
Monitoring Protocols

Desired Future Conditions

What is the ultimate goal of ecological management?

Desired Future Conditions (DFCs)

are clearly articulated

expressions of desired conditions

for populations and ecological systems,

that are possible within the human/mission context

over a set period of time, and

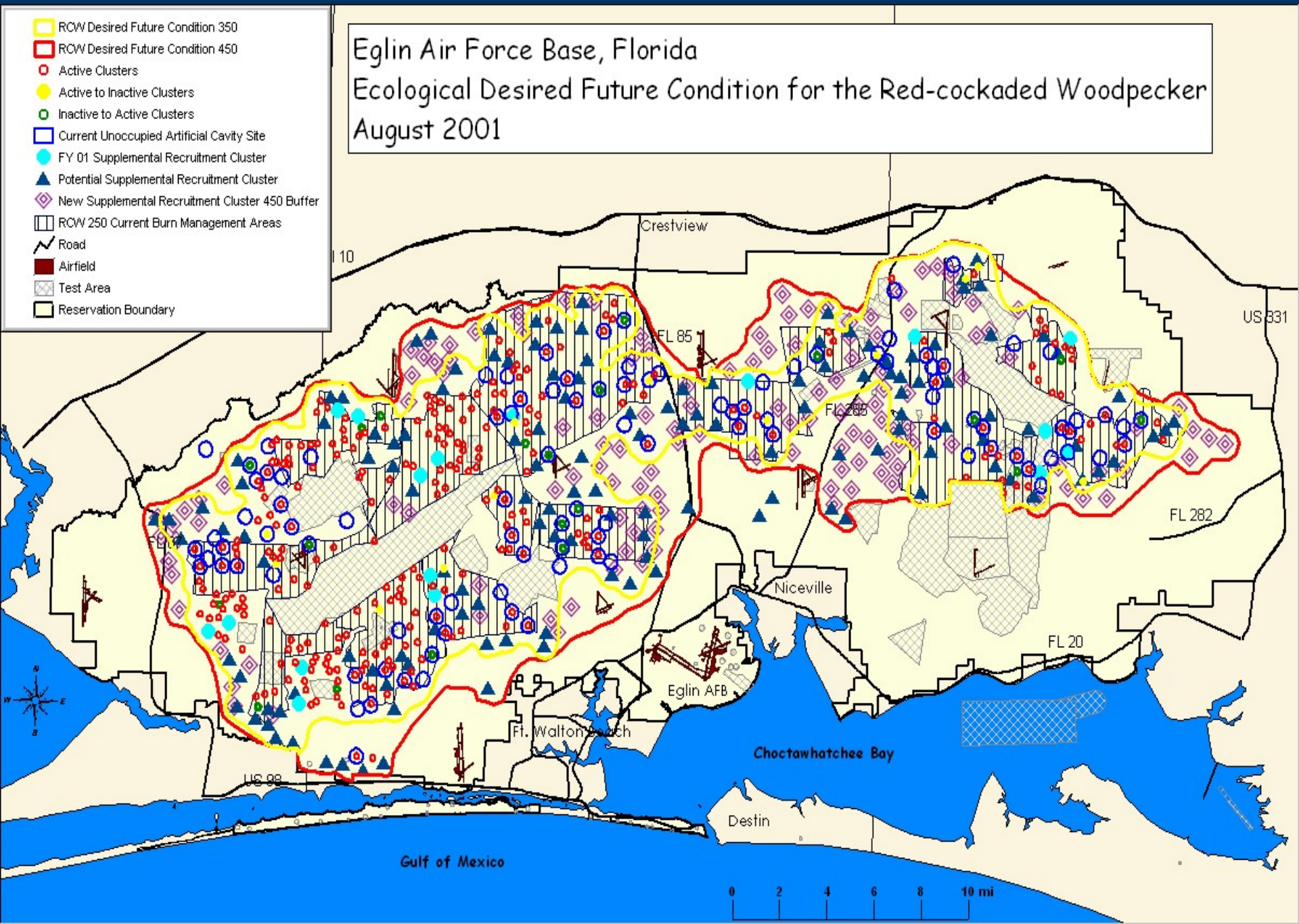
are used to guide management, restoration and land use.

Three Components for DFCs

- What conditions are desired at multiple scales
  - Species
    - abundance
    - population structure
    - spatial arrangement and connectivity
  - Ecological Systems
    - structure and composition
    - function (ecological processes)
    - spatial extent and configuration
- Where those conditions will be restored
- When will those conditions be restored

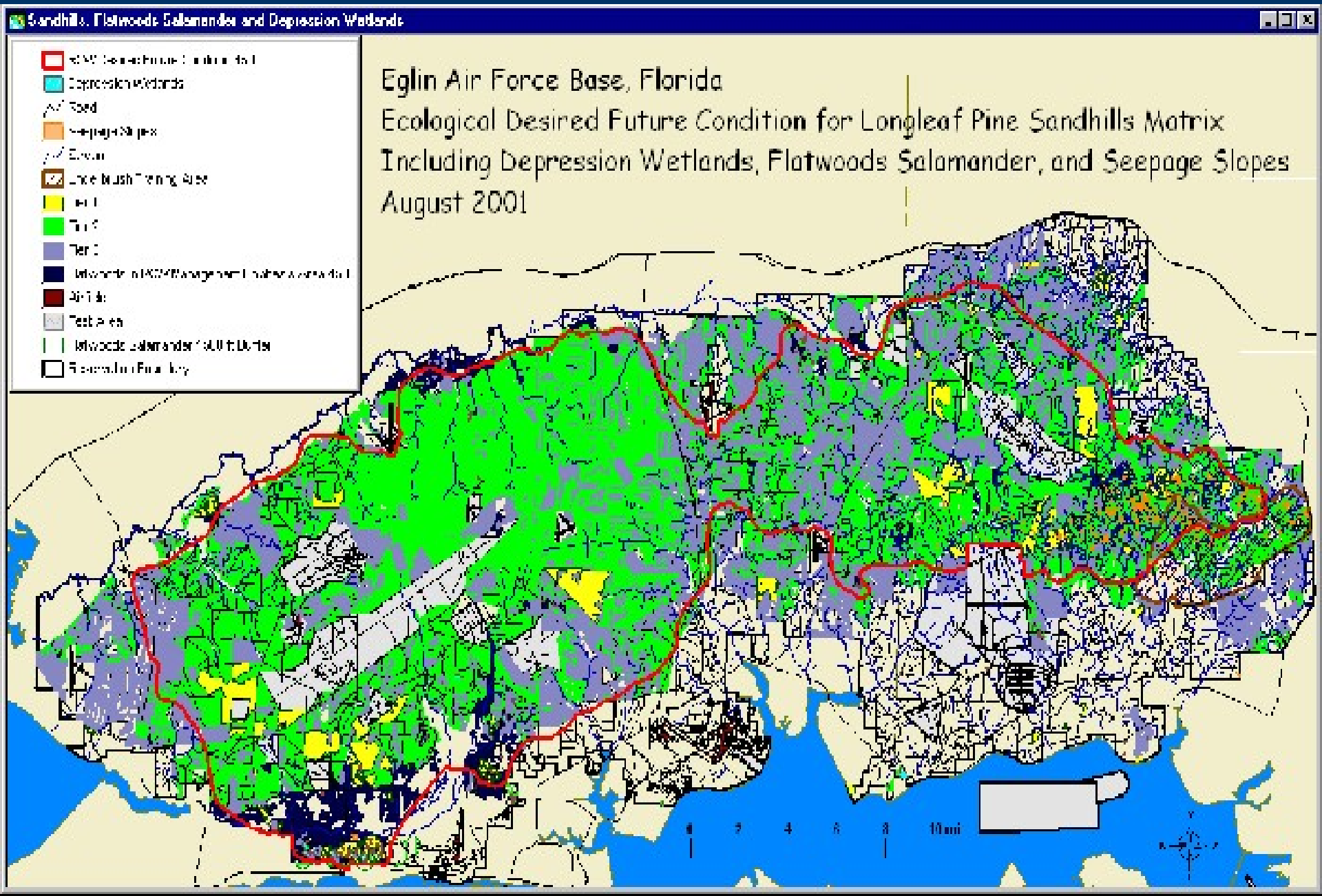
Red Cockaded Woodpecker

- Abundance/Structure: 500 active clusters, containing 450 potential breeding pairs with over 100 of these in the eastern subpopulation
- Spatial Arrangement and Connectivity: Maintain and increase size of western subpopulation, increase size and improve spatial configuration of the eastern subpopulation before connecting eastern subpopulation with the western subpopulation.


RCW Desired Future Condition 350
RCW Desired Future Condition 450
Active Clusters
Active to Inactive Clusters
Inactive to Active Clusters
Current Unoccupied Artificial Cavity Site
FY 01 Supplemental Recruitment Cluster
Potential Supplemental Recruitment Cluster
New Supplemental Recruitment Cluster 450 Buffer
RCW 250 Current Burn Management Areas
Road
Airfield
Test Area
Reservation Boundary
Eglin Air Force Base, Florida
Ecological Desired Future Condition for the Red-cockaded Woodpecker
August 2001
Crestview
I 10
FL 85
US 331
FL 285
FL 282
Niceville
FL 20
Eglin AFB
Ft. Walton Beach
Choctawhatchee Bay
US 98
Destin
Gulf of Mexico
0 2 4 6 8 10 mi

Longleaf Pine Sandhill

- Structure: Longleaf Pine DBH distribution, densities and BA; Understory Oak DBH distribution and density
- Composition: species richness, abundance measures of Graminoids, Legumes, Woody Vines, Woody Species, Invertebrates, Herps, Birds
- Function (Ecological Processes): fire frequency and intensity and light gap formation
- Spatial Extent and Configuration: natural fire blocks or fire blocks approaching 10,000 acres, and a spatial configuration that minimizes edge


Sandhills, Flatwoods Salamander and Depression Wetlands
Eglin Air Force Base, Florida
Ecological Desired Future Condition for Longleaf Pine Sandhills Matrix
Including Depression Wetlands, Flatwoods Salamander, and Seepage Slopes
August 2001
Depression Wetlands
Road
Tier 1
Tier 2
Airfield
Test Area
Flatwoods Salamander
0 2 4 6 8 10mi

DFC's for Other Targets

- Florida Bog Frog
  - assume natural hydrology will protect this species; abate threats to water quality and hydrologic regime
- Atlantic White Cedar/Baygall
  - assume natural processes will conserve it, allow fire to enter these systems, maintain hydrology
- Bottomland Hardwoods
  - assume natural hydrology will maintain this target; abate threats to water quality and hydrologic regime

Desired Future Condition Continuum

Condition-focused DFCs ⟷ Process-focused DFCs

Management works toward a specific natural range of variability of:

- structure
- composition
- spatial extent

Management allows natural processes to function, focusing on:

- maintaining or restoring processes
- abating threats

Sources for Identifying a Desired Future Condition

- Existing Plans and Documents
  - use with caution: extrapolation, assumptions and bias
- Reference Populations or Sites
  - use with caution: unknown historic events, extrapolation
- Historical Records and Photos
  - use with caution: bias
- Expert Opinion
  - use with caution: assumptions and bias

Start somewhere, successive approximation of the ultimate desired future condition

Exercise

Select a project, and start developing a DFC:

- Target: species or ecological system
- What conditions are desired at multiple scales
  - Species: abundance, population structure, spatial arrangement and connectivity
  - Ecological Systems: structure, composition, function, spatial extent and configuration
- Where those conditions will be restored
- When will those conditions be restored
- Source of DFC information:
- What information would improve the DFC?

Discussion

- What difficulties did you have completing the Desired Future Condition?
- What additional information would you like to have?
- Where would you get that information?

Management Objectives

How will the target be managed?

What target attributes will be measured to assess the success of management?

Components of Management Objectives

- The target (species, system) being managed
- How the target will be managed
- Location where management will take place
- The desired future condition for the target
- Attributes that will be measured
- Degree of change for the attributes
- Time frame for management to be effective

Selecting Attributes

Attributes = Metrics = Ecological Indicators

Which of the numerous measures of a species or ecological system best:

- characterize the entire population or system?
- respond to management?
- are simple enough to be effectively monitored?

Attribute Criteria

- Be sensitive to stresses of the system.
  The most useful attribute displays high sensitivity to a particular stress or management action, with a known, predictable, low variability response
- Be anticipatory and predict changes
  that can be averted by management actions
- Be easily measured

Time Frame

Long enough to detect change but short enough to:

- obtain adequate funding
- promote regular reassessment
- allow for modifications
- promote decision-making

Types of Management Objectives

- Target/Threshold Management Objective
  - an estimate of a parameter in the population, such as population size, density, cover, mean height or the structure or composition of an ecological system
- Change/Trend Management Objective
  - a change in a population parameter relative to current conditions, such as the same parameters as above
  - best when insufficient information exists to describe a future condition, state/condition is less important than trend

Types of Management Objectives

- Target/Threshold Management Objective
  - Increase the mean density of a selected species in dune habitat at Eglin AFB to 20 plants/m2 by 2005
  - Decrease the mean cover of a specific invasive species in Unit A at Eglin AFB to less than 5% by 2005
- Change/Trend Management Objective
  - Increase the mean density of a selected species in dune habitat at Eglin AFB by 20% by 2005
  - Decrease the mean cover of a specific invasive species in Unit A at Eglin AFB by 50% by 2005

Exercise

With the same project you used for the DFCs, develop a draft management objective with:

- How the target will be managed
- Location where management will take place
- Attributes that will be measured
- Degree of change for the attributes
- Time frame for management to be effective

Discussion

- What difficulties did you have completing the management objective?
- What additional information would you like to have?
- Where would you get that information?

Sampling Objectives

How precise will the data be?

What amount of change can be detected?

Sampling Objective

- Companion to a management objective whenever monitoring includes sampling procedures
  - Sampling: assessing a portion of a population or ecological system with the intent of making inferences to the whole population or system
- A sampling objective sets a specific goal for the measurement of the target/threshold or change/trend value identified in the management objective

What is Precision and Power?

- Precision: statistical term for the closeness of repeated measurements to one another
  - A measure of the variability of your data
- Power: statistical term that relates the risk of failing to detect a true change
- Goal:
  - minimize the variability of your data so that the estimate of a value is close to the true value
  - minimize the risk of failing to detect a change

How do you Increase Precision and Power?

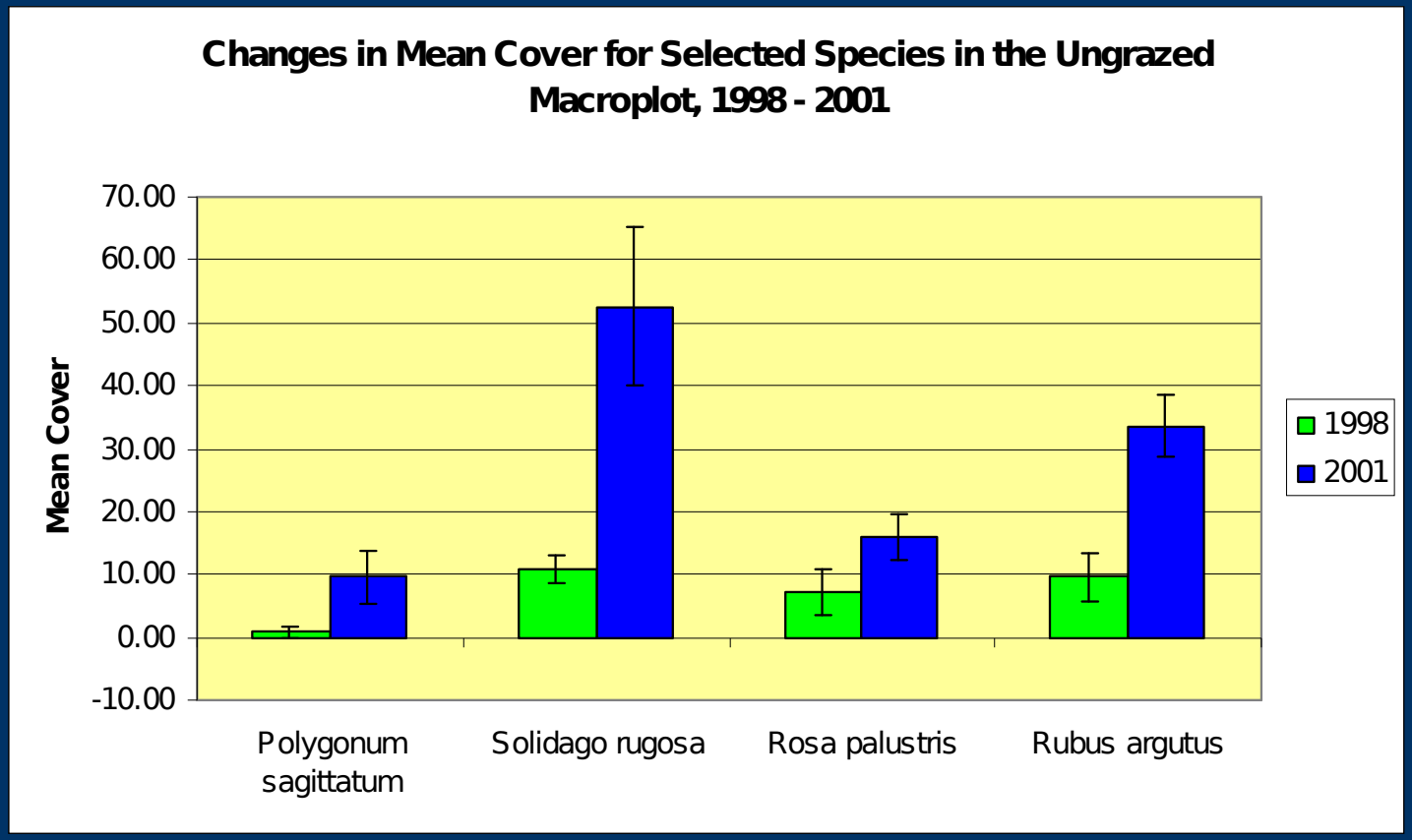
- For **Target/Threshold** Management Objectives:
  - an estimate of a parameter in the population

Precision

- For **Change/Trend** Management Objectives:
  - a change in a population parameter relative to current conditions

Power

Species Composition - Wet Meadow



Sampling Objective Components

- For **Target/Threshold** Management Objectives:
  - Confidence Level
  - Confidence Interval
- For **Change/Trend** Management Objectives:
  - Power
  - Minimal Detectable Change
  - False Change Error Rate

Sampling Objective Components

- For **Target/Threshold** Management Objectives:

We want to be 95% confident (CL) that estimates are within +/- 25% (CI) of the estimated true mean

- For **Change/Trend** Management Objectives:

We want to be 90% sure (Power) of detecting a 20% change (MDC) in density and willing to accept a 1 in 10 chance that it didn't take place (FC)

How do you Increase Precision and Power?

- For **Target/Threshold** Management Objectives:

$$SE = s / \sqrt{n}$$

SE = Standard Error
s = standard deviation
n = sample size

- For **Change/Trend** Management Objectives:

Power = a function of (s, n, MDC, α)

MDC = minimal detectable change
α = false-change error rate

How do you Increase Precision and Power?

- Reducing variability
  - Redefine the sampling universe
  - Change the size and shape of the sampling unit
- Increasing the number of samples
- Accepting a larger Minimum Detectable Change
- Accepting a larger probability of saying a change took place when it didn’t

Size and Shape of the Sample Unit

- Larger square or longer rectangular sample units are more precise and efficient.
- More precise because they capture the variability of the population within the sample unit rather than among sample units.
- More efficient because fewer markers to prepare and carry and fewer sample units to relocate, set up, measure, and process data from.

Example of Desired Future Conditions and Management & Sampling Objectives

- **Desired Future Condition:**
  - to restore a functioning Longleaf Pine System of 225,000 acres at Eglin AFB in the spatial configuration as mapped with the following structural and compositional conditions (density and age of canopy, cover of mid-story, species composition of ground cover, …) by 2050
- **Management Objective:** (one of many)
  - use fire and selective cutting to restore the following functional and structural conditions (density of canopy, cover of mid-story, cover fine fuels) to Longleaf Pine management areas A and B in the next 10 years
- **Sampling Objective:** (one of many)
  - to be 90% confident that estimates of mid-story cover are within 25% of the true value

Process of Assessing Precision

- Determine what level of precision you want before sampling
- Pilot Sampling
- Develop Sampling Design

Sampling Design

Choice of sampling methods that minimize data variability and maximize the detection of change.

- Precision: statistical term for the closeness of repeated measurements to one another
- Repeatability: ability of measurements to be repeated over time with no error
- Efficiency: ability of making the measurements easily and quickly

Eight Sampling Design Decisions

- What is the population of interest?
- What part of the population will be sampled?
- What sampling methods will be used to measure the selected metrics?
- What is the appropriate sampling unit (SU) and the appropriate size and shape?
- How should SU be positioned?
- Should the SU positions be permanent or temporary?
- How often should the SU be sampled?
- How many SU should be sampled?

Exercise

With the same project you used for the DFC and management objective with:

- Complete a Sampling Design no more than 10 pages in length answering all 8 sampling design decisions

Workshops and Collaboration

How do one learn objective-based monitoring?

Where can information be obtained?

The Nature Conservancy's Ecological Monitoring Workshop

- Topics
  - Adaptive Management
  - Sampling Design
  - Sampling Methods
  - Analysis of Monitoring Data

- Field Oriented
- Designed for the Monitoring Practitioner

From Concepts to Implementation

- Ecosystem Management: an emphasis on ecosystems, scale, and collaboration
- Conservation Planning: an operational framework that emphasizes viability and functionality of targets, threats from the human context and strategic actions
- Adaptive Management: an emphasis on uncertainty and adaptiveness

Information Needs and Collaboration

- Target Priorities
- Desired Future Conditions
- Management Experience
- Attribute Selection
- Expected Change and Time Frame
- Methods to Increase Precision and Power
- Statistical Analysis and Interpretation

“All uncertainty is fruitful so long as it is empowered by the wish to understand”

Antonio Machado